White paper

THREE

TRACTS

CONCERNING

THE TORPEDO.

Publiſhed in the PHILOSOPHICAL TRANSACTIONS
for the Years 1773 and 1774.

To Thomas Pennant Esqr.
From Wm. Walsh

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MDCCLXXV.

OF
THE ELECTRIC PROPERTY
OF THE
TORPEDO.

IN A LETTER FROM
JOHN WALSH, ESQ; F.R.S.
TO
BENJAMIN FRANKLIN, ESQ; LL.D. F.R.S.
AC. R. PAR. SOC. EXT. &c.

Read at the ROYAL SOCIETY, July 1, 1773.

To Benjamin Franklin, *Eſq*; *LL.D. F. R. S.*

DEAR SIR, Cheſterfield-Street, July 1, 1773.

I AM concerned that other engagements have prevented me from giving to the Royal Society, before their receſs, a complete account of my experiments on the electricity of the Torpedo; a ſubject not only curious in itſelf, but opening a large field for intereſting inquiry, both to the electrician in his walk of phyſics, and to all who conſider, particularly or generally, the animal œconomy.

To ſupply the deficiency in the beſt manner I am now able, I will requeſt the favour of you to lay before the Society my letter from la Rochelle, of the 12th July 1772, and ſuch part of the letter I afterwards wrote from Paris, as relates to this ſubject. Looſe and imperfect as theſe informations are, for they were never intended for the public eye, they are ſtill the moſt authentic, and ſo far the moſt ſatisfactory I can at preſent offer, ſince the notes I made of the experiments themſelves remain nearly, I am ſorry to ſay it, in that crude and bulky ſtate in which you had the trouble to read them.

Letter from Mr. WALSH to Dr. FRANKLIN, dated la Rochelle, 12th July 1772.

"It is with particular ſatisfaction I make to you my "firſt communication, that the effect of the Torpedo "appears to be abſolutely electrical; by forming its "circuit through the ſame conductors with electricity, "for inſtance metals, and water; and by being inter-"cepted by the ſame non-conductors, for inſtance glaſs, "and ſealing wax. I will not at preſent trouble you "with the detail of our experiments, eſpecially as we "are daily advancing in them; but only obſerve, that "we have diſcovered the back and breaſt of the animal "to be in different ſtates of electricity: I mean in par-"ticular the upper and lower ſurfaces of thoſe two "aſſemblages of pliant cylinders, of which you have "ſeen engravings in Lorenzini *. By the knowledge "of this circumſtance we have been able to direct his "ſhocks, though they were very ſmall, through a "circuit of four perſons, all feeling them; likewiſe "through a conſiderable length of wire held by two in-"ſulated perſons, one touching his lower ſurface, and

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* Obſervazioni intorno alle Torpedini di Stef. Lorenzini 1678.

Redi appears to be the firſt who remarked theſe ſingular parts of the Torpedo in 1666. Franc. Redi, Exper. Nat.

" the other his upper. When the wire was exchanged
" for glaſs, or ſealing-wax, no effect could be obtained:
" but as ſoon as it was reſumed, the two perſons
" became liable to the ſhock. Theſe experiments have
" been varied many ways, and repeated times without
" number, and they all determined the choice of conductors
" to be the ſame in the Torpedo as in the Leyden
" Phial. The ſenſations likewiſe, occaſioned by
" the one and the other in the human frame, are precisely
" ſimilar. Not only the ſhock, but the numbing
" ſenſation which the animal ſometimes diſpenſes, expreſſed
" in French by the words *engourdiſſement* and
" *fourmillement*, may be exactly imitated with the
" Phial, by means of Lane's Electrometer; the regulating
" rod of which, to produce the latter effect, muſt
" be brought almoſt into contact with the prime conductor
" which joins the Phial. We have not yet perceived
" any ſpark to accompany the ſhock, nor the
" pith balls to be ever affected. Indeed all our trials
" have been on very feeble ſubjects, whoſe ſhock was
" ſeldom ſenſible beyond the touching finger: I remember
" but one, of at leaſt two hundred, that I
" myſelf muſt have received, to have extended above
" the elbow. Perhaps the iſle of Ré, which we are
" about to viſit, may furniſh us with Torpedos freſher
" taken and of more vigour, by which a farther inſight
" into theſe matters may be had. Our experiments
" have been chiefly in the air, where the animal was
" more open to our examination than in water. It is

" a ſin-

" a ſingularity that the Torpedo, when inſulated,
" ſhould be able to give us, inſulated likewiſe, forty or
" fifty ſucceſſive ſhocks from nearly the ſame part;
" and theſe with little, if any diminution in their force:
" indeed they were all very minute. Each effort in the
" animal to give the ſhock is conveniently accompanied
" with a depreſſion of his eyes, by which even his
" attempts to give it to non-conductors can be obſerved.
" The animal, with reſpect to the reſt of his body,
" is in a great degree motionleſs, but not wholly ſo.
" You will pleaſe to acquaint Dr. Bancroft, of our
" having thus verified his ſuſpicion concerning the
" Torpedo *, and make any other communication of
" this matter you may judge proper. Here I ſhall be
" glad to excite, as far as I am able, both electricians
" and naturaliſts, to puſh their inquiries concerning
" this extraordinary animal, whilſt the ſummer affords
" them the opportunity."

Extracts of a Letter from Mr. WALSH to Dr. FRANKLIN,
dated Paris, 27th Auguſt, 1772.

—— " I ſpent a complete week in my experiments
" at the Iſle of Ré, and had there every convenience
" for proſecuting them to their extent, except that I
" was reſtrained by the jealouſy of the government
" from making them where the animal was caught.
" At my return to la Rochelle, I communicated to the

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* Bancroft's Natural Hiſtory of Guiana, p. 194.

" members of the Academy of that place, and to " many of the principal inhabitants, all that I had obſerved concerning the Torpedo, in the intention of " ſtirring up a ſpirit of inquiry, both as to its electricity " and general œconomy.

—— " The vigour of the freſh-taken Torpedos at " the Iſle of Ré, was not able to force the torpedinal " fluid acroſs the minuteſt tract of air; not from one " link of a ſmall chain, ſuſpended freely, to another; " not through an almoſt inviſible ſeparation, made by " the edge of a penknife, in a ſlip of tinfoil paſted on " ſealing-wax. The ſpark therefore (of courſe the " attendant ſnapping noiſe) was denied to all our attempts to diſcover it, not only in day-light, but in " complete darkneſs. I obſerved to you, in my laſt, " the ſingularity of the Torpedo being able, when " inſulated, to give to an inſulated perſon a great number of ſucceſſive ſhocks: in this ſituation I have taken " no leſs than fifty from him in the ſpace of a minute " and a half. All our experiments confirmed, that his " electricity was condenſed, in the inſtant of its exploſion, by a ſudden energy of the animal; and as there " was no gradual accumulation, nor retention of it, as " in the caſe of charged glaſs, it is not at all ſurprizing " that no ſigns of attraction or repulſion were perceived " in the pith balls. In ſhort, the effect of the Torpedo " appears to ariſe from a compreſſed elaſtic fluid, reſtoring itſelf to its equilibrium in the ſame way, and " by the ſame mediums, as the elaſtic fluid compreſſed

“ in charged glaſs. The ſkin of the animal, bad con-
“ ductor as it is, ſeems to be a better conductor of his
“ electricity, than the thinneſt plate of elaſtic air.
“ Notwithſtanding the weak ſpring of the torpedinal
“ electricity, I was able, in the public exhibitions of
“ my experiments at la Rochelle, to convey it through
“ a circuit, formed from one ſurface of the animal to
“ the other, by two long braſs wires, and four perſons,
“ which number, at times, was increaſed even to eight.
“ The ſeveral perſons were made to communicate with
“ each other, and the two outermoſt with the wires,
“ by means of water contained in baſins, properly diſ-
“ poſed between them for the purpoſe; each perſon
“ dipping his hands in the neareſt baſins, connectively
“ with his neighbour on either ſide.——

“ The effect produced by the Torpedo, when in air,
“ appeared, on many repeated experiments, to be about
“ four times as ſtrong as when in water.”

A clear and ſuccinct narrative of what paſſed at one of the public exhibitions, alluded to in the laſt letter, appeared in the French Gazette of the 30th October 1772. As it came from a very reſpectable quarter, not leſs ſo from the private character of the gentleman, than from the public offices he held, I muſt deſire leave of the Society to avail myſelf of ſuch a teſtimony to the facts I have advanced, by giving a tranſlation of that narrative.

Extract of a Letter from the Sieur SEIGNETTE, Mayor of la Rochelle, and ſecond perpetual Secretary of the Academy of that City, to the publiſher of the French Gazette.

“ In the Gazette of the 14th Auguſt, you mentioned the diſcovery made by Mr. Walſh, Member of the parliament of England, and of the Royal Society of London. The experiment, of which I am going to give you an account, was made in the preſence of the Academy of this city. A live Torpedo was placed on a table. Round another table ſtood five perſons inſulated. Two braſs wires, each thirteen feet long, were ſuſpended to the ceiling by ſilken ſtrings. One of theſe wires reſted by one end on the wet napkin on which the fiſh lay; the other end was immerſed in a baſin full of water placed on the ſecond table, on which ſtood four other baſins likewiſe full of water. The firſt perſon put a finger of one hand in the baſin in which the wire was immerſed, and a finger of the other hand in the ſecond baſin. The ſecond perſon put a finger of one hand in this laſt baſin, and a finger of the other hand in the third; and ſo on ſucceſſively, till the five perſons communicated with one another by the water in the baſins. In the laſt baſin one end of the ſecond wire was immerſed; and with the other end Mr. Walſh touched the back of the Torpedo, when the five perſons felt a commotion which dif-

"fered in nothing from that of the Leyden experi-
"ment, except in the degree of force. Mr. Walſh,
"who was not in the circle of conduction, received no
"ſhock. This experiment was repeated ſeveral times,
"even with eight perſons; and always with the ſame
"ſucceſs. The action of the Torpedo is communicated
"by the ſame mediums as that of the electric fluid.
"The bodies which intercept the action of the one,
"intercept likewiſe the action of the other. The
"effects produced by the Torpedo reſemble in every
"reſpect a weak electricity."

This exhibition of the electric powers of the Torpedo, before the Academy of la Rochelle, was at a meeting, held for the purpoſe in my apartments, on the 22d July 1772, and ſtands regiſtered in the journals of the Academy.

The effect of the animal was, in theſe experiments, tranſmitted through as great an extent and variety of conductors as almoſt at any time we had been able to obtain it, and the experiments included, nearly, all the points, in which its analogy with the effects of the Leyden Phial had been obſerved. Theſe points were ſtated to the gentlemen preſent, as were the circumſtances in which the two effects appeared to vary. It was likewiſe repreſented to them, That our experiments had been almoſt wholly with the animal in air: That its action in water was a capital deſideratum: That indeed all as yet done was little more than opening the door to inquiry: That much remained to be examined by the Electrician as well as by the Anatomiſt: That as artificial electricity had thrown light on the natural operation of the Torpedo, this might in return, if well conſidered, throw light on artificial electricity, particularly in thoſe reſpects in which they now ſeemed to differ: That for me, I was about to take leave of the animal, as nature had denied it to the Britiſh ſeas; and that the proſecution of theſe reſearches reſted in a particular manner with them, whoſe ſhores abounded with it.

The Torpedo, on this occaſion, diſpenſed only the diſtinct, inſtantaneous ſtroke, ſo well known by the name of the electric ſhock. That protracted but lighter ſenſation, that Torpor or Numbneſs which he at times induces, and from which he takes his name, was not then experienced from the animal; but it was imitated with artificial electricity, and ſhewn to be producible by a quick conſecution of minute ſhocks. This, in the Torpedo, may perhaps be effected by the ſucceſſive diſcharge of his numerous cylinders, in the nature of a running fire of muſketry: the ſtrong ſingle ſhock may be his general volley. In the continued effect, as well as in the inſtantaneous, his eyes, uſually prominent, are withdrawn into their ſockets.

The ſame experiments, performed with the ſame Torpedos, were on the two ſucceeding days repeated before numerous companies of the principal inhabitants of la Rochelle. Beſides the pleaſure of gratifying the curioſity of ſuch as entertained any on the ſubject, and the deſire I had to excite a proſecution of the inquiry, I certainly wiſhed to give all poſſible notoriety to facts, which might otherwiſe be deemed improbable, perhaps by ſome of the firſt rank in ſcience. Great authorities had given a ſanction to other ſolutions of the phænomena of the Torpedo; and even the Electrician might not readily liſten to aſſertions, which ſeemed, in ſome reſpects, to combat the general principles of electricity. I had reaſon to make ſuch concluſions from different converſations I had held on the ſubject with eminent perſons both at London and Paris. It is but juſtice to ſay, that of all in that claſs you gave me the greateſt encouragement to look for ſucceſs in this reſearch, and even aſſiſted me in forming hypotheſes, how the Torpedo, ſuppoſed to be endued with electric properties, might uſe them in ſo conducting an element as water.

After generally recommending to others an examination of the electric powers of theſe animals when acting in water, I determined, before I took my final leave of them, to make ſome farther experiments myſelf with that particular view; ſince, notwithſtanding the familiarity in which we may be ſaid to have lived with them for near a month, we had never detected them in the immediate exerciſe of their electric faculties againſt other fiſh, confined with them in the ſame water, either in the circumſtance of attacking their prey, or defending themſelves from annoyance: and yet that they poſſeſſed ſuch a power, and exerciſed it in a ſtate of liberty, could not be doubted.

A large Torpedo, very liberal of his ſhocks, being held with both hands by his electric organs above and below, was briſkly plunged into water to the depth of a foot, and inſtantly raiſed an equal height into air; and was thus continually plunged and raiſed, as quick as poſſible, for the ſpace of a minute. In the inſtant his lower ſurface touched the water in his deſcent, he always gave a violent ſhock, and another ſtill more violent in the inſtant of quitting the water in his aſcent; both which ſhocks, but particularly the laſt, were accompanied with a writhing in his body, as if meant to force an eſcape: Beſides theſe two ſhocks from the ſurface of the water, which may yet be conſidered as delivered in the air, he conſtantly gave at leaſt two, when wholly in the air, and conſtantly one and ſometimes two, when wholly in the water. The ſhocks in water appeared, as far as ſenſation could decide, not to have near a fourth of the force of thoſe at the ſurface of the water, nor much more than a fourth of thoſe intirely in air.

The ſhocks received in a certain time were not, on this occaſion, counted by a watch, as they had been on a former, when fifty were delivered, in a minute and a half, by the animal in an inſulated and unagitated ſtate: But from the quickneſs, with which the immerſions were made, it may be preſumed there were full twenty of theſe in a minute; from whence the number of ſhocks, in that time, muſt have amounted to above an hundred. This experiment, therefore, while it diſcovered the comparative force between a ſhock in water and one in air, and between a ſhock delivered with greater exertion on the part of the animal and one with leſs, ſeemed to determine, that the charge of his organs with electricity was effected in an inſtant, as well as the diſcharge.

The Torpedo was then put into a flat baſket, open at top, but ſecured by a net with wide meſhes, and, in this confinement, was let down into the water, about a foot below the ſurface; being there touched, through the meſhes, with only a ſingle finger, on one of his electric organs, while the other hand was held, at a diſtance, in the water, he gave ſhocks, which were diſtinctly felt in both hands.

The circuit for the paſſage of the effect being contracted to the finger and thumb of one hand, applied above and below to a ſingle organ, produced a ſhock, to our ſenſation, of twice the force of that in the larger circuit by the arms.

The Torpedo, ſtill confined in the baſket, being raiſed to within three inches of the ſurface of the water, was there touched with a ſhort iron bolt, which was held, half above and half in the water, by one hand, while the other hand was dipped, as before, at a diſtance in the water; and ſtrong ſhocks, felt in both hands, were thus obtained through the iron.

A wet hempen cord being faſtened to the iron bolt, was held in the hand above water, while the bolt touched the Torpedo; and ſhocks were obtained through both thoſe ſubſtances.

A leſs powerful Torpedo, ſuſpended in a ſmall net, being frequently dipped into water and raiſed again, gave, from the ſurface of the water, ſlight ſhocks through the net to the perſon holding it.

Theſe experiments in water manifeſted, That bodies, immerſed in that element, might be affected by immediate contact with the Torpedo; That the ſhorter the circuit in which the electricity moved, the greater would be the effect; And that the ſhock was communicable, from the animal in water, to perſons in air, through ſome ſubſtances.

How far harpoons and nets, conſiſting of wood and hemp, could in like circumſtances, as it has been frequently aſſerted, convey the effect, was not ſo particularly tried as to enable us to confirm it. I mention the omiſſion in the hope that ſome one may be induced to determine the point by expreſs trial.

We convinced ourſelves, on former occaſions, that the accurate Kæmpfer*, who ſo well deſcribes the effect of the Torpedo, and happily compares it with lightning, was deceived in the circumſtance, that it could be avoided by holding in the breath, which we found no more to prevent the ſhock of the Torpedo, when he was diſpoſed to give it, than it would prevent the ſhock of the Leyden Phial.

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* Kæmpf. Amœn. Exot. 1712, p. 514.

Several perſons, forming as many diſtinct circuits, can be affected by one ſtroke of the animal, as well as when joined in a ſingle circuit. For inſtance, four perſons, touching ſeparately his upper and lower ſurfaces, were all affected; two perſons likewiſe, after the electricity had paſſed through a wire into a baſin of water, tranſmitted it from thence, in two diſtinct channels, as their ſenſation convinced them, into another baſin of water, from whence it was conducted, probably in an united ſtate, by a ſingle wire. How much further the effect might be thus divided and ſubdivided into different channels, was not determined; but it was found to be proportionably weakened by multiplying theſe circuits, as it had been by extending the ſingle circuit.

Something may be expected to be ſaid of the parts of the animal immediately concerned in producing the electrical effect. The engraving, which accompanies this letter, while it ſhews the general figure of the Torpedo, gives an internal view of his electric organs. The Society will, beſides, have a full anatomical deſcription of theſe parts from the ingenious Mr. John Hunter, in a paper he has expreſsly written on the ſubject at my requeſt. It would therefore be ſuperfluous for me to ſay any thing either in regard to their ſituation or ſtructure.

I have to obſerve, however, That in theſe double organs reſides the electricity of the Torpedo, the reſt of his body appearing to be no otherwiſe concerned in his electrical effect than as conducting it: That they are ſubject to the will of the animal; but whether, like other double parts ſo controlable, they are exerciſed, at times, ſingly as well as in concert, is difficult to be aſcertained by experiment: That their upper and under ſurfaces are capable, from a ſtate of equilibrium with reſpect to electricity, of being inſtantly thrown, by a meer energy, into an oppoſition of a *plus* and *minus* ſtate, like that of the charged Phial: That, when they are thus charged, the upper ſurfaces of the two are in the ſame ſtate of electricity; as are the under ſurfaces of the two, though in a contrary to that of the upper; for no ſhock can be obtained by an inſulated perſon touching both organs above, or both below: And that the production of the effect depends ſolely on an intercourſe being made between the oppoſite ſurfaces of the organs whether taken ſingly or jointly.

All the parts bordering on the organs act, more or leſs, as conductors, either through their ſubſtance or by their ſuperficies. While an inſulated perſon, placing two fingers on the ſame ſurface of one or both organs, cannot be affected; if he removes one of his fingers to any ſuch contiguous part, he will be liable to a ſhock: but this ſhock will not be near, perhaps not half, ſo violent, as one taken immediately between the oppoſite ſurfaces of the organ: which ſhews the conduction to be very imperfect.

The parts, which conduct the beſt, are the two great lateral fins bounding the organs outwardly, and the ſpace lying between the two organs inwardly. All below the double tranſverſe cartilages ſcarcely conduct at all, unleſs when the fiſh is juſt taken out of water and is ſtill wet, the mucus, with which he is lubricated, ſhewing itſelf, as it dries, to be of an inſulating nature.

The organs themſelves, when uncharged, appeared to be, not interiorly we might ſuppoſe, but rather exteriorly, conductors of a ſhock. An inſulated perſon touching two torpedos, lying near one another on a damp table, with fingers placed, one on the organ of one fiſh, and another on the organ of the other, was ſenſible of ſhocks, ſometimes delivered by one fiſh, and ſometimes by the other, as might be diſcovered by the reſpective winking of their eyes. That the organs, uncharged, ſerved ſome way or other as conductors, was confirmed with artificial electricity, in paſſing ſhocks by them; and in taking ſparks from them, when electrified.

The electric effect was never perceived by us to be attended with any motion or alteration in the organs themſelves, but was frequently accompanied with a little tranſient agitation along the cartilages which ſurround both organs: this is not diſcernible in the plump and turgid ſtate of the animal, while he is freſh and vigorous; but as his force decays, from the relaxation of his muſcles, his cartilages appear through the ſkin, and then the ſlight action along them is diſcovered.

May we not from all theſe premiſes conclude, that the effect of the Torpedo proceeds from a modification of the electric fluid? The Torpedo reſembles the charged Phial in that characteriſtic point of a reciprocation between its two ſurfaces. Their effects are tranſmitted by the ſame mediums; than which there is not perhaps a ſurer criterion to determine the identity of ſubtile matter: They, beſides, occaſion the ſame impreſſion on our nerves. Like effects have like cauſes. But it may be objected, that the effects of the Torpedo, and the charged Phial, are not ſimilar in all their circumſtances; that the charged Phial occaſions attractive or repulſive diſpoſitions in neighbouring bodies; and that its diſcharge is obtained through a portion of air, and is accompanied with light and ſound; nothing of which occurs with reſpect to the Torpedo.

The inaction of the electricity of the animal in theſe particulars, whilſt its elaſtic force is ſo great as to tranſmit the effect through an extenſive circuit and in its courſe to communicate a ſhock, may be a new phænomenon, but is no ways repugnant to the laws of electricity; for here too, the operations of the animal may be imitated by art.

The ſame quantity of electric matter, according as it is uſed in a denſe or rare ſtate, will produce the different conſequences. For example, a ſmall Phial, whoſe coated ſurface meaſures only ſix ſquare inches, will, on being highly charged, contain a denſe electricity capable of forcing a paſſage through an inch of air, and afford the phænomena of light, ſound, attraction, and repulſion. But if the quantity condenſed in this Phial, be made rare by communicating it to three large connected jars, whoſe coated ſurfaces ſhall form together an area 400 times larger than that of the Phial (I inſtance theſe jars becauſe they are ſuch as I uſe); it will, thus dilated, yield all the negative phænomena, if I may ſo call them, of the Torpedo; it will not now paſs the hundredth part of that inch of air, which in its condenſed ſtate it ſprung through with eaſe; it will now refuſe the minute interſection in the ſtrip of tinfoil; the ſpark and its attendant ſound, even the attraction or repulſion of light bodies, will now be wanting; nor will a point brought however near, if not in contact, be able to draw off the charge: and yet, with this diminiſhed elaſticity, the electric matter will, to effect its equilibrium, inſtantly run through a conſiderable circuit of different conductors, perfectly continuous, and make us ſenſible of an impulſe in its paſſage.

Let me here remark, that the ſagacity of Mr. Cavendiſh in deviſing and his addreſs in executing electrical experiments, led him the firſt to experience with artificial electricity, that a ſhock could be received from a charge which was unable to force a paſſage through the leaſt ſpace of air.

But, after the diſcovery that a large area of rare electricity would imitate the effect of the Torpedo, it may be inquired, where is this large area to be found in the animal? We here approach to that veil of nature, which man cannot remove. This, however, we know, that from infinite diviſion of parts infinite ſurface may ariſe, and even our groſs optics tell us, that thoſe ſingular organs, ſo often mentioned, conſiſt like our electric batteries of many veſſels, call them cylinders or hexagonal priſms, whoſe ſuperficies taken together furniſh a conſiderable area.

I rejoice in addreſſing theſe communications to You. He, who predicted and ſhewed that electricity wings the formidable bolt of the atmoſphere, will hear with attention, that in the deep it ſpeeds an humbler bolt, ſilent and inviſible: He, who analyſed the electrified Phial, will hear with pleaſure that its laws prevail in animate Phials: He, who by Reaſon became an electrician, will hear with reverence of an inſtinctive electrician, gifted in his birth with a wonderful apparatus, and with the ſkill to uſe it.

However I may reſpect your talents as an electrician, it is certainly for knowledge of more general import, that I am impreſſed with that high eſteem, with which I remain,

Dear Sir,

Your affectionate

and obedient ſervant,

JOHN WALSH.

EXPLANATION of the PLATE

OF THE

Male and Female Torpedo, or Electric Ray.

FIG. I.

A view of the under ſurface of the female.

a. An expoſure, or flaying off the ſkin, of the right electric organ, which conſiſts of white pliant columns, in a cloſe and for the moſt part hexagonal arrangement, giving the general appearance of a honey-comb in miniature. Theſe columns have been ſometimes denominated cylinders; but having no interſtices, they are all angular, and chiefly ſix-cornered.

b. The ſkin which covered the organ, ſhewing on its inward ſide an hexagonal net-work.

c. The noſtrils in the form of a creſcent.

d. The mouth in a creſcent contrary to that of the noſtrils, furniſhed with ſeveral rows of very ſmall hooked teeth.

e. The branchial apertures, five on each ſide.

f. The place of the heart.

g. *g*. *g*. The

g. g. g. The place of the two anterior tranſverſe cartilages, which, paſſing one above and the other below the ſpine, ſupport the diaphragm, and uniting towards their extremities, form on either ſide a kind of clavicle and ſcapula.

h. h. The outward margin of the great lateral fin.

i. i. Its inner margin, confining with the electric organ.

k. The articulation of the great lateral fin with the ſcapula.

l. The abdomen.

m. m. m. The place of the poſterior tranſverſe cartilage, which is ſingle, united with the ſpine, and ſupports on each ſide the ſmaller lateral fins.

n. n.
n. n. } The two ſmaller lateral fins.

o. The anus.

p. The fin of the tail.

FIG. II.

A view of the upper ſurface of the female.

a. a. An expoſure of the upper part of the right electric organ.
b. The ſkin which covered the organ.
c. The eyes, prominent and looking horizontally outwards, but capable of being occaſionally withdrawn into their ſockets.
d. Two circular apertures communicating with the mouth, and furniſhed with a membrane, which in air, as well as in water, plays regularly backwards and forwards acroſs the aperture in the office of inſpiration.
e. The place of the right branchia.
f. The two fins of the back.
g. g. The place of the anterior tranſverſe cartilages.

FIG. III.

A view of the under ſurface of the male, whoſe ſize, as here repreſented, is, in general, ſmaller than that of the female.

a. a. Two appendices, diſtinguiſhing the male ſpecies.

ANATOMICAL OBSERVATIONS

ON THE

TORPEDO.

By JOHN HUNTER, F.R.S.

Read at the ROYAL SOCIETY, July 1, 1773.

ANATOMICAL OBSERVATIONS, &c.

I WAS deſired ſome time ſince, by Mr. Walſh, whoſe experiments at la Rochelle had determined the effect of the Torpedo to be electrical, to diſſect and examine the peculiar organs by which that animal produces ſo extraordinary an effect. This I have done in ſeveral ſubjects furniſhed to me by that Gentleman.

I am now deſired by him to lay before the Society, the obſervations I have made; and for the better underſtanding of them, to preſent, on his part, a male and female Torpedo in ſpirits; in the latter of which the electric organs are expoſed in different views and ſections; likewiſe a copper-plate, which he took care to have engraved, exhibiting thoſe organs.

Of the general ſtructure and anatomy of the Torpedo I ſay nothing, ſince the animal does not differ very materially, excepting in its electric organs (as they have been properly named by Mr. Walſh) from the reſt of the Rays, of which family it is well known to be. I will only premiſe, that the Torpedo, of which I treat, is about eighteen inches long, twelve broad, and in its central or thickeſt part two inches thick; which is nearly the ſize of the female ſpecimen, ~~now preſented to the Society,~~ as well as of that from which the plate was taken: but where there is any difference in the organ ariſing from difference in ſize, notice will be taken of it in this account.

The electric organs of the Torpedo are placed on each ſide of the *cranium* and gills, reaching from thence to the ſemicircular cartilages of each great fin, and extending longitudinally from the anterior extremity of the animal to the tranſverſe cartilage, which divides the thorax from the abdomen; and within theſe limits they occupy the whole ſpace between the ſkin of the upper and of the under ſurfaces: they are thickeſt at the edges near the center of the fiſh, and become gradually thinner towards the extremities. Each electric organ, at its inner longitudinal edge, is unequally hollowed; being exactly fitted to the irregular projections of the *cranium* and gills. The outer longitudinal edge is a convex elliptic curve. The anterior extremity of each organ, makes the ſection of a ſmall circle; and the poſterior extremity makes nearly a right angle with the inner edge. Each organ is attached to the ſurrounding parts by a cloſe cellular membrane, and alſo by ſhort and ſtrong tendinous fibres, which paſs directly acroſs, from its outer edge, to the ſemicircular cartilages.

They are covered above and below, by the common ſkin of the animal; under which there is a thin *faſcia* ſpread over the whole organ. This is compoſed of fibres, which run longitudinally, or in the direction of the body of the animal: theſe fibres appear to be perforated in innumerable places; which gives the *faſcia* the appearance of being faſciculated; its edges all around, are cloſely connected to the ſkin, and at laſt appear to be loſt, or to degenerate into the common cellular membrane of the ſkin.

Immediately under this, is another membrane exactly of the ſame kind, the fibres of which in ſome meaſure decuſſate thoſe of the former, paſſing from the middle line of the body outwards and backwards. The inner edge of this is loſt with the firſt deſcribed; the anterior, outer, and poſterior edges are partly attached to the ſemicircular cartilages, and partly loſt in the common cellular membrane.

This inner *faſcia* appears to be continued into the electric organ, by ſo many proceſſes, and thereby makes the membranous ſides or ſheaths of the columns, which are preſently to be deſcribed; and between theſe proceſſes the *faſcia* covers the end of each column, making the outermoſt or firſt partition.

Each organ, of the fiſh under conſideration, is about five inches in length, and at the anterior end three in breadth, though it is but little more than half as broad at the poſterior extremity.

Each conſiſts wholly of perpendicular columns, reaching from the upper to the under ſurface of the body, and varying in their lengths, according to the thickneſs of the parts of the body where they are placed; the longeſt column being about an inch and a half, the ſhorteſt about one fourth of an inch in length, and their diameters about two tenths of an inch.

The figures of the columns are very irregular, varying according to ſituation and other circumſtances. The greateſt number of them are either irregular Hexagons, or irregular Pentagons; but from the irregularity of ſome of them, it happens that a pretty regular quadrangular column is ſometimes formed. Thoſe of the exterior row are either quadrangular or hexagonal; having one ſide external, two lateral, and either one or two internal. In the ſecond row they are moſtly pentagons.

Their coats are very thin, and ſeem tranſparent, cloſely connected with each other, having a kind of looſe network of tendinous fibres, paſſing tranſverſely and obliquely between the columns, and uniting them more firmly together. Theſe are moſtly obſervable where the large trunks of the nerves paſs. The columns are alſo attached by ſtrong inelaſtic fibres, paſſing directly from the one to the other.

The number of columns in different Torpedos of the ſize of that now offered to the Society, appeared to be about 470 in each organ, but the number varies according to the ſize of the fiſh *. Theſe columns increaſe, not only in ſize, but in number, during the growth of the animal; new ones forming perhaps every year on the exterior edges, as there they are much the ſmalleſt. This proceſs may be ſimilar to the formation of new teeth, in the human jaw, as it increaſes.

Each column is divided by horizontal partitions, placed over each other, at very ſmall diſtances, and forming numerous interſtices, which appear to contain a fluid. Theſe partitions conſiſt of a very thin membrane, conſiderably tranſparent. Their edges appear to be attached to one another, and the whole is attached by a fine cellular membrane to the inſide of the columns. They are not totally detached from one another: I have found them adhering, at different places, by blood-veſſels paſſing from one to another.

The number of partitions contained in a column of one inch in length, of a Torpedo which had been preſerved in proof ſpirit, appeared upon a careful examination to be one hundred and fifty: and this number in a given length of column appears to be common to all ſizes in the ſame ſtate of humidity, for by drying they may be greatly altered; whence it appears probable that the increaſe in the length of a column, during the growth of the animal, does not enlarge the diſtance between each partition in proportion to that growth; but that new partitions are formed, and added to the extremity of the column, from the *faſcia*.

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* In a very large Torpedo, the number of columns in one electric organ were 1182.

The partitions are very vaſcular; the arteries are branches from the veins of the gills, which convey the blood that has received the influence of reſpiration. They paſs along with the nerves to the electric organ, and enter with them; then they ramify, in every direction, into innumerable ſmall branches upon the ſides of the columns, ſending in from the circumference all around upon each partition ſmall arteries, which ramify and anaſtomoſe upon it; and paſſing alſo from one partition to another, anaſtomoſe with the veſſels of the adjacent partitions.

The veins of the electric organ paſs out, cloſe to the nerves, and run between the gills, to the auricle of the heart.

The nerves inſerted into each electric organ, ariſe by three very large trunks from the lateral and poſterior part of the brain. The firſt of theſe, in its paſſage outwards, turns round a cartilage of the *cranium*, and ſends a few branches to the firſt gill, and to the anterior part of the head, and then paſſes into the organ towards its anterior extremity. The ſecond trunk enters the gills between the firſt and ſecond openings, and, after furniſhing it with ſmall branches, paſſes into the organ near its middle. The third trunk, after leaving the ſkull, divides itſelf into two branches, which paſs to the electric organ through the gills; one between the ſecond and third openings, the other between the third and fourth, giving ſmall branches to the gill itſelf. Theſe nerves having entered the organs, ramify in every direction, between the columns, and ſend in ſmall branches upon each partition, where they are loſt.

The magnitude and the number of the nerves beſtowed on theſe organs, in proportion to their ſize, muſt on reflection appear as extraordinary as the phænomena they afford. Nerves are given to parts either for ſenſation or action. Now if we except the more important ſenſes of ſeeing, hearing, ſmelling, and taſting, which do not belong to the electric organs, there is no part even of the moſt perfect animal, which, in proportion to its ſize, is ſo liberally ſupplied with nerves; nor do the nerves ſeem neceſſary for any ſenſation which can be ſuppoſed to belong to the electric organs. And with reſpect to action, there is no part of any animal, with which I am acquainted, however ſtrong and conſtant its natural actions may be, which has ſo great a proportion of nerves.

If it be then probable, that thoſe nerves are not neceſſary for the purpoſes of ſenſation, or action, may we not conclude that they are ſubſervient to the formation, collection, or management of the electric fluid; eſpecially as it appears evident, from Mr. Walſh's experiments, that the will of the animal does abſolutely controul the electric powers of its body; which muſt depend on the energy of the nerves.

How far this may be connected with the power of the nerves in general, or how far it may lead to an explanation of their operations, time and future diſcoveries alone can fully determine.

An EXPLANATION of the ENGRAVING of the TORPEDO.

FIG. I.

The upper ſurface of the electric organ.

AA. The common ſkin of the animal.
B. The inſpiratory opening.
C. The eye.
D. The part in which the gills are incloſed.
EEE. The ſkin diſſected off from the electric organ, and turned outwards; the honeycomb appearance of its internal ſurface correſponding with the upper ſurface of the organ.
F. The part of the ſkin which covered the gills, with ſome ramifications of an excretory duct upon it.
GGG. The upper ſurface of the electric organ, formed by the upper extremities of the perpendicular columns.

FIG. II.

The right electric organ divided horizontally into nearly two equal parts at the place where the nerves enter; the upper half being turned outwards.

AA. BB. CC. DD. The correſponding parts of the trunks of the nerves, as they emerge from the gills, and ramify in the electric organ.

AA. The firſt or anterior trunk ariſing juſt before the gill.

BB. The ſecond or middle trunk ariſing behind the firſt gill.

CC. The anterior branch of the third trunk ariſing behind the ſecond gill.

DD. The poſterior branch of the third trunk ariſing behind the third gill.

F I G. III.

A perpendicular ſection of the Torpedo a little below its inſpiratory openings.

AA.	The upper ſurface of the fiſh.
BB.	The muſcles of the back as divided by the ſection.
C.	The Medulla Spinalis.
D.	The Oeſophagus.
E.	The left gill ſplit, to expoſe the courſe of a trunk of the nerve through it.
F.	The breathing ſurface of the right gill.
GG.	The fins.
HH.	The perpendicular columns which compoſe the electric organ, with a repreſentation of their horizontal partitions.
I.	One of the trunks of the nerves, with its ramifications.

Fig.1.

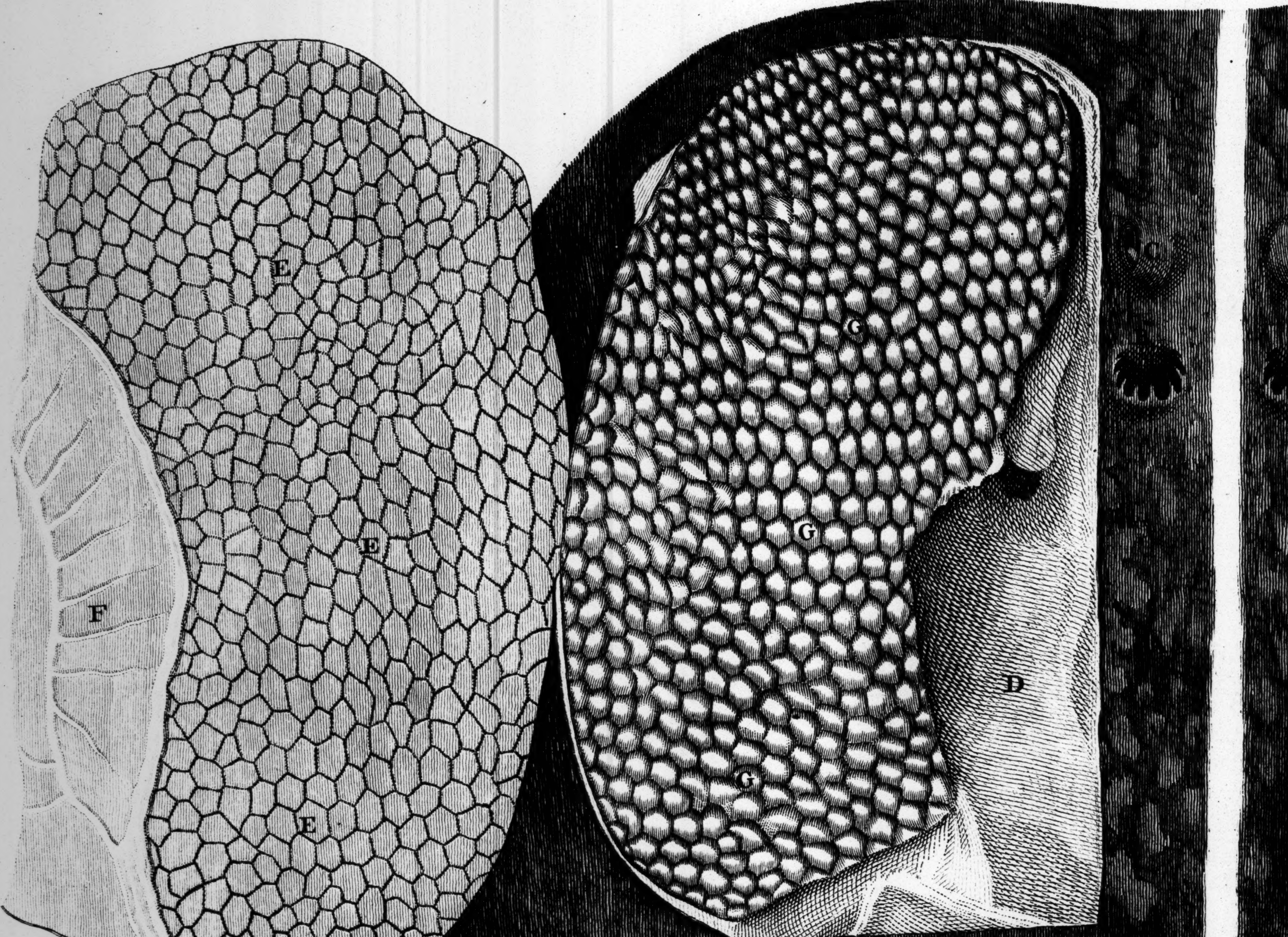


Fig.

Fig. 2.

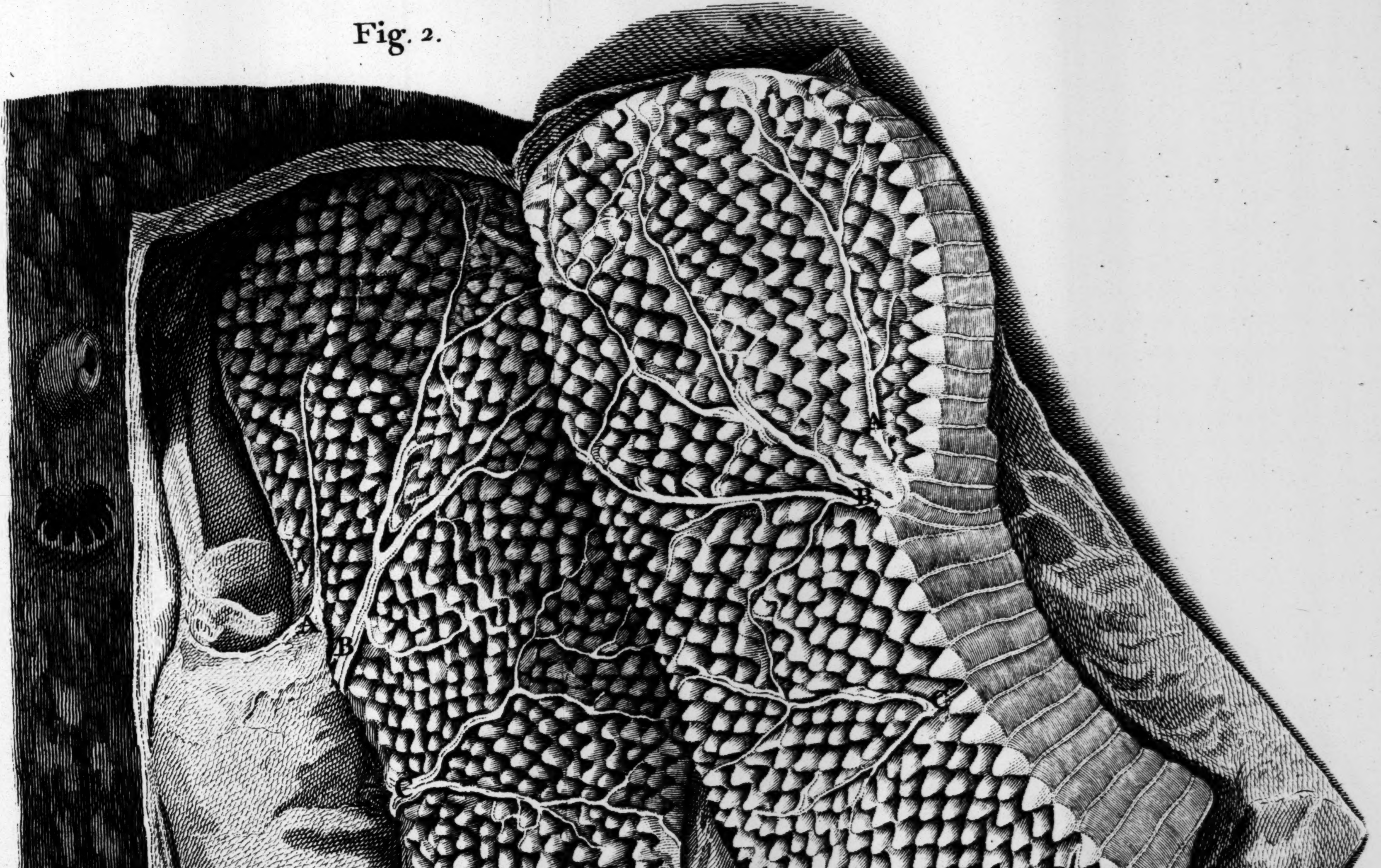


Fig. 3.

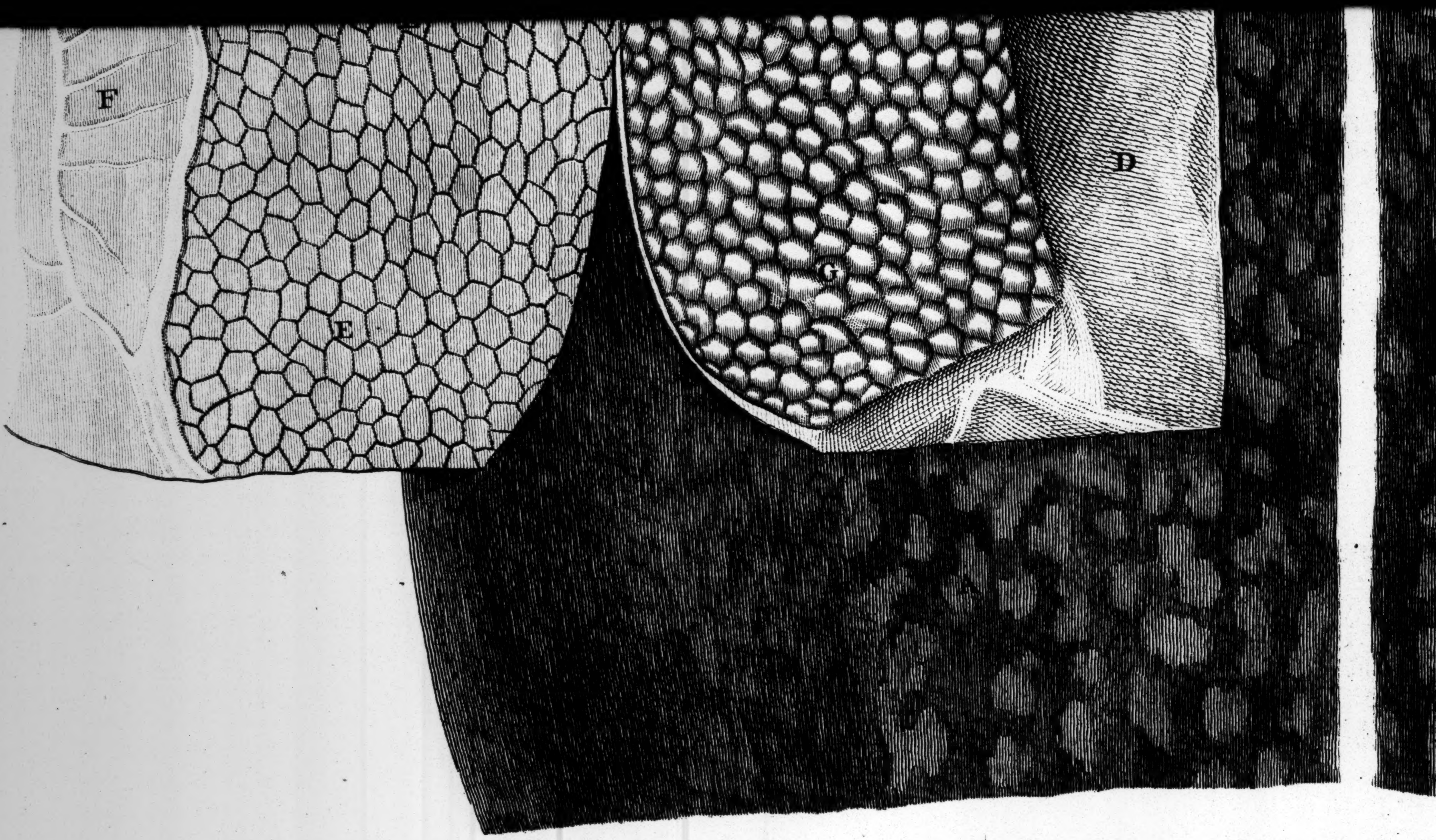
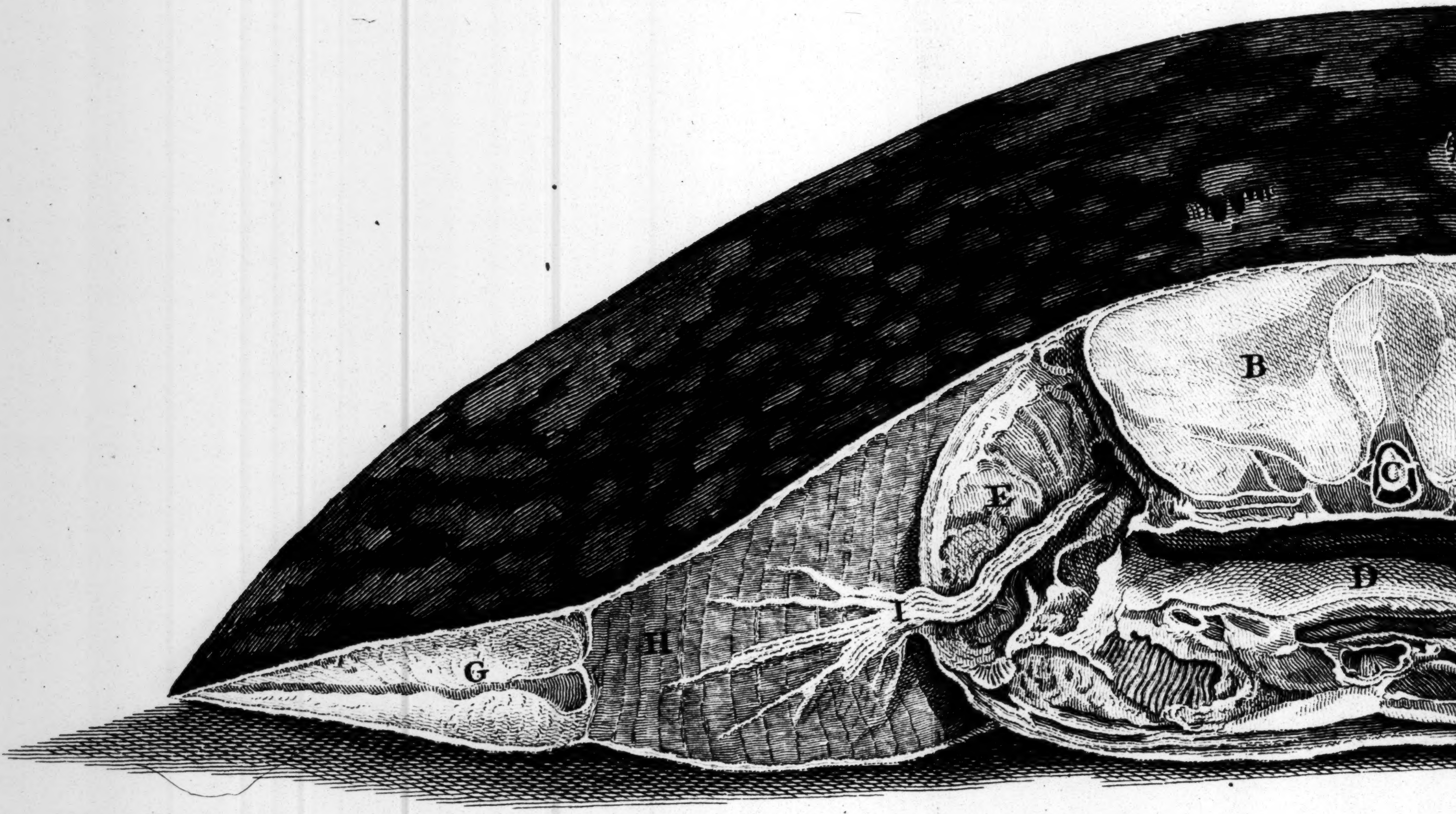


Fig.



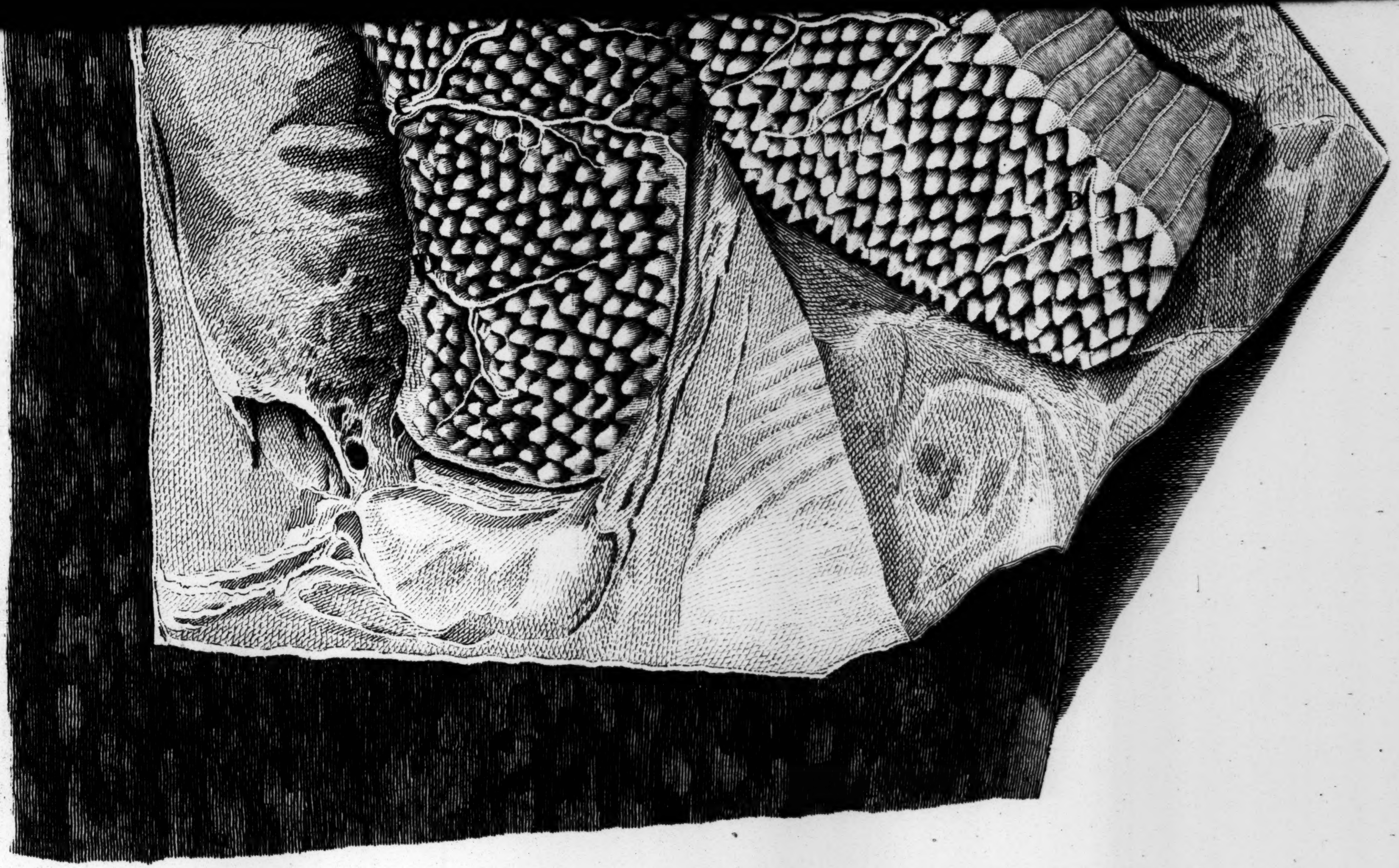
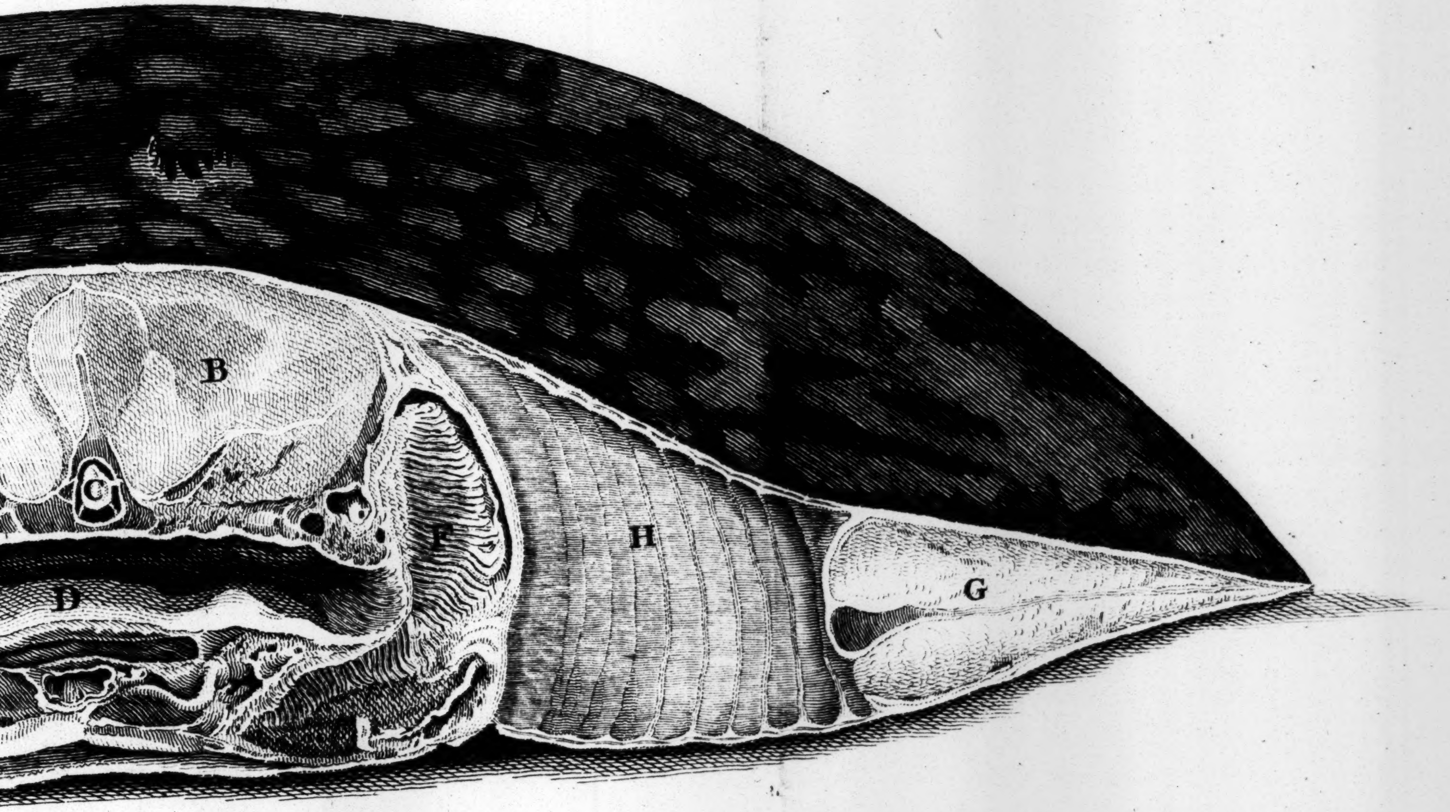


Fig. 3.



Js Roberts del. et sculp.

OF

TORPEDOS

FOUND ON THE

COAST OF ENGLAND.

IN A LETTER FROM

JOHN WALSH, ESQ; F.R.S.

TO

THOMAS PENNANT, ESQ; F.R.S.

Read at the ROYAL SOCIETY, JUNE 23, 1774.

TO

THOMAS PENNANT, ESQ;

DEAR SIR, Cheſterfield-Street, June 23, 1774.

TO the Author of the Britiſh Zoology it will, I am perſuaded, be no unwelcome information, that the Torpedo, or Electric Ray, frequents the ſhores of this iſland, contrary to a received opinion among Naturaliſts, who have in general conſidered it as an inhabitant only of warmer climates.

In conſequence of inquiries I had ſet on foot in ſome of our ſouthern fiſhing ports, two Torpedos, taken in Torbay, one in the beginning of Auguſt, and the other in the beginning of November, laſt year, have been actually ſent up to this metropolis. The firſt, procured for me by the good offices of Mr. Amyatt, Apothecary in Berkeley-Square, arrived during my abſence; but it was examined, and the electrical organs were ſucceſsfully injected by Mr. John Hunter. The ſecond, forwarded to me by Mr. Grant, a principal fiſhmonger in the Land-carriage branch, then at Brixham, came up very freſh and perfect, in one of his fiſh-machines. This I weighed and meaſured before it was touched by the diſſecting knife, and found it to weigh fifty-three pounds avoirdupois, and to meaſure four feet in length, two feet and a half in its extreme breadth, and four inches and a half in its extreme thickneſs.

The largeſt Torpedo I met with in the neighbourhood of la Rochelle, where upwards of ſeventy paſſed through my hands, weighed little more than ten pounds, and meaſured not quite two feet in length, nor quite ſixteen inches in breadth: and the largeſt I have read of is that mentioned by Rhedi to Lorenzini*, weighing twenty-four pounds, without doubt of Leghorn, which make about eighteen avoirdupois. Though this Mediterranean Torpedo has been ever conſidered as of an extraordinary ſize, it is exceeded in weight nearly three to one by our enormous Britiſh Torpedo.

The back of it was of a dark-aſh-colour, with ſomewhat of a purple caſt, but not at all motled like thoſe of the Atlantic Coaſt of France, nor regularly marked with eyes, as they have been called, like ſome found in the Mediterranean. Its under part was white, ſkirted however with the ſame aſh-colour, which towards its tail became almoſt univerſal. The ſide fins being a little contracted and curled up, prevented the preciſe meaſurement of its breadth, but it appeared to hold the general proportion obſerved in thoſe of la Rochelle; that is, the breadth was two-thirds of the length *. Its electric organs likewiſe were proportionate with theirs, each organ meaſuring fifteen inches in extreme length, and eight in extreme breadth. In ſhort, the Torpedo of Torbay no way differed from thoſe I ſaw in the Bay of Biſcay but in ſize and colour; and perhaps this difference may be thought rather caſual than denoting a ſpecific diſtinction.

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* Lorenz. Oſſ. intor. alle Torp. p. 4.

It was a female, without any ſigns of pregnancy. The inteſtines contained, with ſome black ſlime, two vertebres of a fiſh, ſeemingly of the cod kind. The electrical organs of this Torpedo were likewiſe injected by Mr. Hunter, though not with his firſt ſucceſs, from the burſting of the artery in the operation; he determined, however, the number of columns in one organ to amount to 1182, and fully confirmed the obſervation he formerly made, that their numerous horizontal partitions were very vaſcular.

Shall I take notice that the reſt of this fiſh was dreſſed and brought to table, and that ſome of my friends ſuffered a little for their curioſity in taſting it? Rondelet ſpeaks unfavourably of the Torpedo as food; and tells us, that at Venice the Prefect of Health forbids it to be ſold in the market. But to deem it wholeſome diet, we

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* The breadth of the Ray-Torpedo of Brazil is, according to Marcgrave, juſt one-third of the length, falling in with the proportion of the *Squatino-Raia*. See Marcg. Lib. iv. Cap. 6.

have the ſanction of Hippocrates as well as Galen; and if forbid at Venice when Rondelet was there, in the markets of France I know it to be ſold. The truth is, that the electrical organs, which make one half of the animal, are, though wholeſome to be eaten, an inſipid mucilage; but its muſcular part is, at leaſt, as palatable as the fleſh of the other Rays: among theſe the old and overgrown are ever in little requeſt. Our Torpedo was doubtleſs ſuch; and we muſt beſide confeſs that, as a rarity, it had been kept too long.

The firſt Torpedo was not weighed; but Mr. Hunter, who examined both, aſſured me, that they appeared to him equal in ſize, and alike in every other reſpect; indeed their electrical organs, preſerved to this hour, ſhew them to have been of the ſame magnitude. The firſt was a female likewiſe, and not pregnant.

The following accounts were received from Brixham, concerning Torpedos found in that quarter.

From Mr. Philip Lyde, Surgeon at Brixham, who forwarded the firſt, on the 4th of Auguſt, 1773.

“ I ſend a Torpedo, or Numb-fiſh, which had, when “ living, the greateſt effect, as I am informed by the “ men who caught it. There have been three taken “ this week. The one ſent ſeems to be of the largeſt “ ſize.”

In an earlier account, dated the 23d June, it is mentioned that one or two are caught there every week.

From Mr. Grant, fiſhmonger, who ſent the ſecond Torpedo, on the 3d November, 1773.

"The Torpedo, or Numb-fiſh, is by no means "plenty in theſe parts, as it rarely happens that more "than one is taken at a time; nor can the proper "ſeaſon for catching them be aſcertained, as they have "been ſeen at all times of the year. The uſual depth "of water in which they are caught is from thirty-ſix "to forty fathom; and being of the Ray kind, they "are commonly taken with them. As to the time "when their young are to be ſeen, no ſatisfactory in"formation can be obtained; but it is imagined that "the ſeaſon for them and the Rays is the ſame. Their "numbing quality is pretty ſtrong through the net, "though much weaker than when they are taken out. "The general name by which they are known here, is "the Numb or Cramp-fiſh. Few or no ſmall Torpedos "are to be met with in theſe parts, thoſe hitherto "caught being from ten to ſixty, ſeventy, and eighty "pounds weight; which may probably proceed from "the young being thrown away promiſcuouſly with "other offal fiſh."

At la Rochelle, during the intire month of July, moſt of the larger female Torpedos, being thoſe from fifteen inches to two feet in length, were found with an uncertain number of eggs in their matrices, the largeſt females appearing to have the greateſt number. The eggs of the ſame female differed little from each other as to forwardneſs; nor did the eggs of one female differ much from thoſe of another: the embryo in all was but little advanced. A letter from M. Saunier of la Rochelle, written about ſix weeks after I had left that place, informed me, that on the 10th September, he opened a very large Torpedo of about two feet and a quarter by one and a half, and diſcovered floating in the left matrice nine fetuſes quite formed, near two inches long, and diſtinct from them nine eggs, in no ſtate of forwardneſs; and that in the right matrice he met with four ſuch fetuſes and nine ſuch eggs. The obſervation, therefore, of Ariſtotle, that the Torpedo brings forth at the autumnal equinox, is well founded, notwithſtanding Lorenzini has queſtioned the fact.

From the remarkable ſuperfetation in this inſtance, we may beſides infer, that the Torpedo, agreeably to Ariſtotle's information concerning the cartilaginous fiſh in general, goes with young near ſix months; as the eggs here found ſeem, from their being ſo little advanced in ſo late a time of the year, to be deſtined for the ſpring-brood. Lorenzini's diſſections, of female Torpedos big with eggs in February and March, and of others without any in April, ſhew that they produce about the vernal as well as autumnal equinox. This was confirmed by the many young torpedos we met with in the month of July, from four and a half to ſix

inches

inches long, which were evidently the offspring of that year. Among theſe, however, was one, taken on the 4th July, weighing one ounce, and meaſuring four inches and a half by three, which had ſtill its native yolk unconſumed in its abdomen. By this circumſtance it appears, that there may be a production likewiſe at Midſummer; but our general obſervations led us to conclude, that it principally takes place at the two equinoxes. I have dwelt the longer on the ſeaſon in which foreign Torpedos bring forth, as we are yet entirely ignorant on that point with regard to thoſe of our colder climate, and as this knowledge may, in ſome degree, aſſiſt us in knowing when and where to look for the animal. Moſt fiſh, we are told, approach the ſhore in the ſummer ſeaſon; and the Torpedo will doubtleſs then, in queſt of food, and of a warmer element, both for itſelf and for its young, haunt the ſhoal water. In the cold and tempeſtuous part of the year, we ſhall probably find it in a deeper ſea, which then affords it the more mild and ſtill retreat.

My learned friend Dr. George Baker has procured for me a drawing and ſome account of a Torpedo, taken about five years ſince in Mount's Bay in Cornwall. The particulars, as they were lately collected by Mr. Scobell of Penzance, from the fiſherman who took it, are theſe: "that he judged it on memory to have weighed "about forty pounds, and to have been about three "feet long, and two and a half broad; that its ſkin

" was ſmooth like an eel, dark-brown on the back,
" and white underneath; and that it had been caught
" with a large hook, in the month of March, on
" ſandy ground."

For the ſake of Oppian's fine deſcription of the capture of the Torpedo, which Claudian has elegantly paraphraſed, and which you, ſtruck with the paſſage, have rendered in Engliſh metre, I am glad the Torpedo is found to take the hook. That deſcription, though thought to have been fabulous, proves to be no leſs juſt in each circumſtance, than, as it was always confeſſed to be, poetically beautiful in the whole.

But to catch with the greateſt ſucceſs the Torpedo, as well as other flat fiſh, which keep near the ground, the trawl, or drag-net, muſt be uſed. This kind of fiſhing is much practiſed in Torbay; but in Mount's Bay, as I am informed, not yet adopted; which may be the chief reaſon why the Torpedo has but ſeldom been taken at the one, and ſo very frequently at the other place.

I had an opportunity laſt autumn of making a ſhort viſit to Dungarvan in Ireland, where Smith in his Hiſtory of Waterford, as you have remarked, mentions a Torpedo of ſix or eight pounds to have been found about thirty years ſince. The fiſhery there, which is very conſiderable, is wholly carried on with hook and line, and the fiſhermen were entire ſtrangers to the Torpedo. But at Ring, a fiſhing village in the neighbourhood, furniſhing about fourteen or fifteen ſmall veſſels, with which they practiſe pole-trawling, the fiſhermen were acquainted with it. They told me, that they ſometimes caught one or two in a year, and ſometimes none for two or three years; that they had taken two that year, and one the year preceding; that theſe were about eighteen inches long, and fourteen broad, and were caught a league off ſhore; that the fiſh benumbs thoſe who touch it, and that they had been benumbed by it; and that its name in Iriſh is *Aunghelláw*. From this name it might ſeem that they confounded it with the Angel-fiſh: but by their deſcription, both of the animal and its effects, it was plain they knew and meant the Torpedo.

To prove the electrical effect of the animal, the curious ſhould be informed, not only where to find, but how beſt to preſerve it alive. The Electric Ray is ſo far amphibious as to exiſt in air twenty-four hours: in freſh water it ſurvives but little longer. Well-boats, kept in ſalt water, and not put into much motion, may beſt ſuit it: In reſervoirs on ſhore, which on ſea-coaſts are not unfrequent, it will be ſubject to be annoyed, notwithſtanding its electrical armour, by the Sea-leach and the common Sea-crab. A commodious well-boat we experienced might ſoon be made from a ſmall flat-bottom boat, termed by the French *Pouſſe pied*; which, partitioned with laths into three or four chambers, and ſecured in the ſame manner at the top, kept floating, from its leaky ſtate, juſt even with the water. In this pen we were able to preſerve them ſeveral days, and always without food; for though in the ſtomach of theſe animals, when taken, a Plaice or Surmullet may, as we have ſeen, be found, yet in confinement they neglect all kinds of prey: it will be eaſy however, as they are of a quiet nature, to force them to ſwallow food, if neceſſary.

But the frequent, and perhaps favourite, ſituation of the Torpedo is to lie in concealment under ſand. If he be placed by deſign, as he is ſometimes left by accident, in any hollow of a ſandy beach, from whence the tide has juſt retired, he ſwims to that brink where the water is ſtill draining away, and on finding himſelf unable after repeated attempts to puſh himſelf over the ſhallow, and follow the courſe of the tide, he begins with admirable addreſs to bury himſelf in the ſand, and by a gentle but quick flapping of his extremities all round ſoon ſinks himſelf a bed, and in the action throws the ſand in a light ſhower over his back. Neither the animal nor the ſpot he is in can now be diſtinguiſhed; ſave only that, on a nice ſearch, his two ſmall inſpiratory foramina, and their membranes at play, may be perceived. It is in this ſituation that the Torpedo gives his moſt forcible ſhock, which throws down the aſtoniſhed paſſenger who inadvertently ſteps on him.

I have thus ſhewn that Great Britain too claims the Torpedo, or Electric Ray; that ours is the *broad marine* ſort, which Socrates, as Meno thought, reſembled; and that it is the *black Torpedo*, whoſe influence ſubdues obſtinate Head-achs, and the Gout itſelf*. In announcing to our Naturaliſts and Electricians the preſence of this wonderful gueſt, I ſhould certainly felicitate our Invalids on their acquiſition, but that *the Leyden phial contains all his magic power*.

I remain, with true eſteem,

Dear Sir,

Your affectionate

and obedient ſervant,

JOHN WALSH.

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* Scribonius Largus, Cap. 1. & 41. See alſo ſeveral of the early phyſicians, Roman and Arabian, for different cures attributed by them to the effect of the Torpedo.

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